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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/785,858	02/16/2001	Shane P. Leiphart	MI22-1636	7367

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EXAMINER	
CANTELMO, GREGG	
ART UNIT	**PAPER NUMBER**
1745	

DATE MAILED: 11/10/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/785,858	LEIPHART	
	Examiner	Art Unit	
	Gregg Cantelmo	1745	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 November 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *35-39,41-48 and 75* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *35-39,41-48 and 75* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. In response to the amendment received November 4, 2004:

   a. Claims 35-39, 41-48 and 75 are pending;

   b. The 112 rejection of claim 75 is withdrawn in light of the amendment to claim 75;

   c. The prior art rejections stand.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 35-39, 41-45 and 75 are rejected under 35 U.S.C. 103(a) as being unpatentable over Besser in view of Shan, Colgan and Marieb, all of record and for the reasons of record.

Besser discloses a method of sputtering (a PVD process) aluminum or aluminum alloy films on a semiconductor, then sputtering a titanium film on the aluminum layer while reacting the titanium with the aluminum to deposit a titanium alloy layer on the aluminum, and thereafter sputtering a titanium nitride film on the alloy layer. The titanium is deposited on the first layer of aluminum or aluminum alloy in a second processing chamber 230 and when maintaining the upper temperature for processing the titanium, the deposition will result in essentially all of the titanium alloying with the

aluminum during deposition of the titanium which effectively then is a deposition of a titanium alloy layer (abstract; col. 3, ll. 5-24; col. 4, ll. 13-51 as applied to claims 35, 49 and 58).

During the deposition of the titanium layer the film is heated to approximately 350° C and by teaching of an upper limit of 450 ° C, can also be set above 360 ° C (paragraph bridging columns 3 and 4). After completion of the films on the substrate, the substrate is removed from the tool to allow for the processing of additional substrates. The titanium layer is deposited to 100 angstroms (col. 4, ll. 22 as applied to claims 36 and 37).

The first layer can be either aluminum or an aluminum alloy (col. 3, ll. 12-15 as applied to claims 38 and 39).

The titanium and titanium nitride layers are formed in the same chamber 230 (col. 4, ll. 12-15 and 29-33 as applied to claim 42).

The titanium is deposited on the first layer of aluminum or aluminum alloy in a second processing chamber 230 and when maintaining the upper temperature for processing the titanium, the deposition will result in essentially all of the titanium alloying with the aluminum (as applied to claim 43).

The differences between the instant claims and Besser are that Besser does not disclose forming the outermost portion of the aluminum layer at a temperature of 400° C or more (claim 35); or of preventing the outermost portion from cooling below 360° C during deposition of the first titanium layer (claim 35); or of forming the layers into a conductive line (claim 35); of providing a substrate having an opening extending through

an insulating layer to a diffusion region (claim 35); of forming the outermost portion of the aluminum layer at a temperature of 360° C or more during the deposition of the third layer (claim 41); of the first deposition temperature being at least 450° C (claim 44); of the first deposition temperature being greater than 450° C (claim 45), providing an insulative material over the substrate, forming a contact opening within the insulative material and depositing the underlayer/wetting layer and first aluminum layer over the substrate (claims 35 and 75).

With respect to forming the outermost portion of the aluminum layer at temperatures of at least 360 ° C and at least 400° C (claims 35 and 41):

Shan teaches that the remainder of the metal is deposited while the semiconductor wafer is held at a relatively high temperature (e.g., when the metal is an aluminum alloy, about 400° C. to about 500° C which allows the deposited metal to reflow through grain. The hot aluminum deposition can be continued until a fully planarized surface is obtained.

The motivation for depositing the outermost portion of the aluminum at temperatures of at least 400° C is to provide reflow of the aluminum film.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Besser by depositing the outer portion of the aluminum at a temperature of at least 400° C since it would have allowed the deposited metal to reflow through the grain and provided optimal conditions for forming a planarized aluminum film.

With respect to preventing the temperature of the outermost portion of the aluminum film from going below 360° C (claims 35, 44, and 45):

As discussed above, Besser teaches that the titanium is heater within a range from 250° C to 450 ° C, with an approximate exemplified temperature of 350° C. Besser also recognized that the Ti reacts with Al to form TiAl3 (col. 4, ll. 24-29). It is also known that maintaining temperatures of greater than 350° C will ensure reaction between titanium and aluminum to readily form TiAl3. Marieb discloses sputtering titanium over the aluminum layer and that heating the device from a range of about 350° C-450° C accelerates the reaction between the titanium and aluminum to form the desired TiAl3 product. The thickness of the film can be optimized so that all of all of the titanium film is reacted (col. 4, ll. 3-20).

Thus it would have been obvious to maintain the temperature to be greater than 350° C, held to be about 360° C, since it would have provided requisite temperature conditions to react the depositing titanium with the aluminum. TiAl3 increases the electromigration lifetime of the film.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Besser by ensuring that the temperature of the first layer does not go below about 360° C during deposition of the titanium since it would have provided optimal temperature conditions wherein the depositing titanium would have reacted with the aluminum to form a layer of TiAl3. Such a layer being known to have increased the electromigration lifetime of the multilayer device.

With respect to sustaining the temperature of the aluminum to be at least 360° C between the depositing of the first layer and the titanium or titanium alloy:

The combined teachings of Besser and Marieb teaches that it in order to react the aluminum with the titanium to firm TiAl3, the temperature of substrate must be in a range of about 350-450° C.

Shan further teaches that heating the aluminum to temperatures between 400 and 500° C is desirable to allow the aluminum metal to flow through the grains and form a planar surface.

In applying the teaching of Shan to that of Besser, it would have been obvious to heat the aluminum layer to temperatures between 400 and 500° C to allow the aluminum metal to flow through the grains and form a planar surface on the substrate.

Thereafter, in transferring the aluminum coated substrate at the desired temperature disclosed by Shan into the adjacent titanium deposition chamber, the transfer time of the Endura 5500 (the same one used by both Besser and the instant application) is not sufficiently long enough to cause the temperature to significantly decrease.

Even further, Marieb teaches that the deposition temperature of titanium on the aluminum layer must be 350-450° C to cause formation of TiAl3. It would not have been obvious to permit the aluminum layer to cool below the minimum temperature required for the formation of TiAl3 in the adjacent deposition step since it would have reduced the throughput of the system by requiring an additional heating step prior to depositing the titanium. Furthermore maintaining the aluminum at the temperature

specified by Shan ensures the planarization of the aluminum layer immediately prior to the titanium deposition.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Besser in view of Shan and Marieb by maintaining the aluminum-coated substrate at a temperature of at least 360° C between the aluminum and titanium deposition steps since it would have maintained the aluminum planarization temperature immediately prior to forming the titanium layer and prevented the need for an additional heating step by keeping the temperature of the substrate in the same range acceptable for both deposition processes. In addition it is held that the Endura 5500 deposition chamber used by both Besser and the instant application has a substrate transfer rate which is sufficiently short enough to prevent substantial cooling of wafers between deposition chambers.

With respect to photopatterning the layers to form a conductive line (claim 35):

Colgan discloses forming an interconnect for a semiconductor device where an aluminum alloy film is sputtered on a substrate, with subsequent Ti and TiN sputtered in succession. The layers are then photolithographically etched to form pattern lines (Col. 2, line 62 through col. 3, line 7; col. 4, ll. 34-40).

After depositing the multilayer structure Shan photopatterns the layers into a conductive line (see Example 1).

The motivation for patterning the deposited layers is to form wiring patterns useful in interconnect structures.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Besser by patterning the deposited layers as taught by Colgan and Shan since it would have formed wiring patterns for forming interconnects.

With respect to providing an insulative material over the substrate, forming a contact opening within the insulative material and depositing the underlayer/wetting layer (i.e., the first layer) and first aluminum layer over the substrate and insulating layer and filling the openings (claims 35 and 75):

Besser discloses forming a titanium underlayer on the substrate prior to forming the aluminum layer (col. 3, ll. 10-15). The underlayer is equivalently understood in the art to be a wetting layer. The process is designed for fabrication of semiconductor devices (col. 1, ll. 20-25). Furthermore the multilayer structure disclosed therein is for vias or contacts in semiconductor devices (see col. 1, ll. 22-57 and col. 5, ll. 7-19). Contact opening or vias are commonly formed in insulating layers of a semiconductor device and provide electrical contact between adjacent layers.

Typical semiconductor substrates include forming providing an insulative material over the substrate, forming a contact opening within the insulative material and depositing the underlayer/wetting layer and first aluminum layer over the substrate as evident from the instant applications prior art admission (page 1).

Shan teaches of metallization of semiconductor layers includes providing a dielectric layer 1 on a substrate 7, forming contacts or vias in the substrate and

thereafter depositing the multilayer metallization layers 3-8 on the substrate (col. 1, ll. 10-20 and Fig. 1).

The motivation for providing the substrate arrangement of Shan is that it provides an initial insulating layer between the substrate and metallization layers and provides an insulative material for forming contacts or vias on the substrate surface.

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Besser by providing the substrate arrangement of Shan since it would have provided an initial insulating layer between the substrate and metallization layers and provided an insulative material for forming contacts or vias on the substrate surface.

Response to Arguments

4. Applicant's arguments with respect to claims 35-45 have been considered but are not persuasive.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Applicant's response fails to seasonably present any clear reasoning or arguments as to the combination of references applied in the prior art rejection above. Applicant's argument is structured such that it discusses each reference alone with respect to what each individual references teaches or fails to teach or "contribute toward

suggesting". The arguments do not make any tenable position for withdrawing the rejection in the context of the *combination* of the references as structured and reasoned in the rejection above.

Claim Rejections - 35 USC § 103

5. Claims 46-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Besser in view of Shan, Colgan and Marieb as applied to claims 35-39 and 41-45 above, all of record and for the reasons of record.

The difference not yet discussed is cooling the outermost portion of the first layer from the first deposition temperature by about 25° C or less (claims 46-48).

The claim limitations include a cooling by zero degrees (or less).

Besser forms the claimed structure and recognized the applicability of temperature ranges for the deposition of titanium from 250-450° C. Furthermore to change the titanium sputtered material to TiAl3 it is advantageous to set the deposition temperature to be from 350-450° C to increase the electromigration lifetime of the device (Marieb). Shan also teaches that temperatures of 400-500° C are desirable when forming the outer portion of an aluminum film to provide adequate reflow of the aluminum to reduce void formation and form planar films.

Thus it would be apparent to form the aluminum film outer portion in a range of 400-500° C as taught by Shan and thereafter form the titanium film in a range of 350-500° C. Noting an overlap of these ranges, one of ordinary skill would have further found it obvious to use temperatures that overlap to provide optimal conditions with which both films can be formed without the need for changing process variables. Thus

a temperature near or about that which both of these films can be deposited to achieve the desired result would have been preferred to reduce the process time required for setting different temperature conditions.

In addition the limitations set forth in claims 46-48 are drawn to particular ranges of temperatures and does not appear to provide any novel effect not achieved by the process conditions set forth in the prior art of record.

Generally, differences in ranges will not support the patentability of subject matter encompassed by the prior art unless there is evidence indicating such ranges is critical. In re Boesche , 617 F.2d 272, 205 USPQ 215 (CCPA 1980). In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955). In re Hoeschele, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969).

Therefore it would have been obvious to one of ordinary skill in the art at the time the claimed invention was made to modify the teachings of Besser such that any temperature relationship between the first and second films was applied so long as the temperatures achieved the same resultant multilayer device as formed by the prior art of record above. Furthermore, it has been held that when the difference between a claimed invention and the prior art is the range or value of a particular variable, then a prima facie rejection is properly established when the difference in the range or value is minor. Titanium Metals Corp. of Am. v. Banner, 778 F.2d 775, 783, 227 USPQ 773, 779 (Fed. Cir. 1985).

Response to Arguments

6. Applicant provides no additional arguments to the rejection of claims 46-48 apart from those drawn to claim 35. The arguments to the rejection of claim 35 are moot in light of the new grounds of rejection.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Gregg Cantelmo whose telephone number is (571) 272-1283. The examiner can normally be reached on Monday to Thursday from 9 a.m. to 6 p.m. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Pat Ryan, can be reached on (571) 272-1292. The fax phone number for

the organization where this application or proceeding is assigned is 703-872-9306. FAXES received after 4 p.m. will not be processed until the following business day. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Gregg Cantelmo
Primary Examiner
Art Unit 1745

gc

November 6, 2004